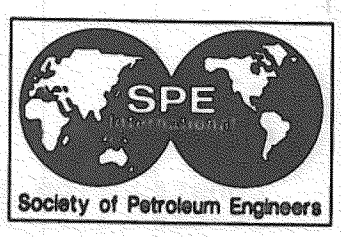

SPE 25961

Proposed Changes to EPA Class II Well Construction Standards and Area of Review Procedures

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This paper was prepared for presentation at the SPE/EPA Exploration & Production Environmental Conference held in San Antonio, Texas, U.S.A., 7-10 March 1993.

ABSTRACT

The Environmental Protection Agency (EPA) is proposing amendments to its Underground Injection Control (UIC) program regulations (40 CFR parts 144 and 146) as they pertain to Class II (oil and gas-related) wells. The proposed amendments revise current provisions relating to construction standards and apply the "area of review" and corrective action requirements to previously exempt wells "authorized by rule."

The proposed modifications build upon recommendations made by a Federally-chartered Advisory Committee pursuant to the findings of an internal Mid-Course Evaluation effort and a General Accounting Office Report.

Under the provisions of Section 1425 of the Safe Drinking Water Act (SDWA), these amended regulations would not need to be adopted verbatim by the States; however, EPA will require that "primacy" States demonstrate that their programs are still effective in light of these new Federal requirements.

BACKGROUND

EPA has primary enforcement responsibility to administer the Underground Injection Control (UIC) program under provisions set forth in the Safe Drinking Water Act (SDWA). EPA has been involved in a series of efforts over the last five years which led to a re-examination of the regulations governing Class II injection wells. These regulations are directly applicable in States where EPA implements the program and form the basis for judging whether delegated ("primacy") State programs are effective in protecting underground sources of drinking water (USDWs).

EPA believes that there are several significant issues that warrant amendments to the current regulations. First, the Agency's Report to Congress (1987) on management of oil and gas production wastes identified as an issue the continued use of minimal well

construction practices in some States [1]. Similarly, the Mid-Course Evaluation (1989) of the Class II program identified the need to re-evaluate the regulations as they pertain to construction requirements, particularly with respect to the level of protection afforded to specific USDWs [2].

Second, the Mid-Course Evaluation final report recommended that EPA study the risks posed by abandoned oil and gas wells within the "zone of endangering influence" of active injection wells to determine whether additional controls are required. This recommendation was echoed by a General Accounting Office (GAO) report which concluded that EPA should establish regulations and/or guidance to make existing wells subject to "area of review" requirements to deal with the issue of abandoned wells [3]. Based upon these reports, the EPA will propose amendments to the UIC regulations under 40 CFR 146.22 for Construction Requirements and 40 CFR 146.24 as it pertains to the Area of Review requirement.

Under the provisions of the Federal Advisory Committee Act, EPA established an advisory committee to help in performing its duties and responsibilities as prescribed under Part C (Protection of Underground Sources of Drinking Water) of the Safe Drinking Water Act. The Committee was charged with developing consensus recommendations which EPA would use as the basis for the proposed revisions to the regulations.

Committee members were selected to provide a representative cross-section of concerned parties. Members represented petroleum producing companies, trade associations, public and environmental interest organizations, other Federal agencies (DOE, BLM) and State UIC regulatory agencies (CA, TX, KS, OH). The Committee submitted its recommendations in a final report to EPA on March 23, 1992 [4].

WELL CONSTRUCTION AND MECHANICAL INTEGRITY TESTING

At the time the current regulations relating to Class II wells were promulgated (1982), EPA agreed to accept a variety of construction practices that had been sanctioned, historically, by a number of oil and gas producing States. Some of these accepted practices employ only one physical element (e.g., a single long string casing or a single string of tubing set on a packer in an open hole) to isolate USDWs from potential invasion by injected fluids. Current regulations require only minimal monitoring of injection operations in these simple well configurations.

Current regulations stipulate only that "..all Class II wells shall be cased and cemented to prevent movement of fluids into or between underground sources of drinking water.." [40 CFR 146.22(b)(1)]. The major problem concerning UIC program oversight responsibility arises from the fact that the regulations do not specify how this regulation is to be met. For example, even though the regulations state that one of the factors to be considered in specifying casing and cementing requirements is the "..depth to the base of all USDWs.." [40 CFR 146.22(b)(1)(ii)], these regulations do not require that surface casing be set below the base of the USDWs. Another example of a contradiction arising from the imprecise wording of the regulations concerns the

injection of fluids in the annular space between the outermost (surface) casing string and the long string casing. In this scenario, the injected fluid would flow into the annular space between the long string casing and the exposed rock formations in the bore hole wall. This practice could impose a threat of contamination to any USDWs exposed in the well bore. Although acceptable in the past, this practice currently is prohibited by an overwhelming majority of the oil and gas producing States.

Due to the considerable latitude provided by the current regulatory language in 40 CFR 144.6(b), injection wells may not always be constructed so as to offer adequate protection of USDWs. Current UIC regulations allow the UIC Director significant latitude in setting the construction standards to be met in his/her State. About 60 percent of all Class II injection wells feature a conventional construction program. Conventional wells are equipped with:

- surface casing set and cemented to protect USDWs of 3,000 milligrams/liter (mg/l) total dissolved solids (TDS) or less;
- long-string casing that extends from the surface to (or through) the injection zone, and is cemented either partially (for some specified vertical distance above the top of the injection zone) or completely back into the surface casing; and
- injection tubing set on a packer.

These three construction elements in a conventional well are often referred to and interchangeable with the regulatory language phrase "layers of protection."

Although the majority of Class II wells are conventional completions, several States still permit unconventional well construction programs. An unconventional well lacks one or more of the described construction elements (i.e., layers of protection). About 40 percent of EPA's Class II well inventory (approximately 66,500 wells) lack at least one construction element or layer of protection [5]. The American Petroleum Institute reports that a well lacking just one layer of protection is 800 times more likely to leak into a USDW [6]. Approximately 7,000 wells in 22 States lack not one but two layers of protection. In these wells the injection brine is separated from USDWs by only one pipe wall thickness. In some cases the annular space between the outside of the pipe and the bore hole wall is not even cemented. Most of these unconventional wells are tested for mechanical integrity only every five years.

In addition, 17,500 unconventional wells without tubing and packer can not be tested using the simple, diagnostic annulus pressure test applied to conventional wells. Most unconventional wells must utilize indirect methods that are not always capable of detecting leaks that can endanger USDWs.

Except for a few specialized storage wells, there is no technical justification for unconventional completions. The primary reason that operators employ unconventional well construction is cost. Unconventional wells are cheaper to construct. In many cases,

unconventional wells are used extensively by small operators producing shallow, marginally economic, oil reservoirs.

PROPOSED NEW CONSTRUCTION STANDARDS

The EPA Advisory Committee recommended that the existing regulatory language be amended to require that all Class II wells drilled and completed after the new regulations are promulgated be constructed in compliance with the prescribed minimum standards. This requirement would also apply to those producing wells that are drilled after the date the rule is promulgated and subsequently converted to injection. Existing wells that have less protection than that mandated for new wells will be subject to more frequent mechanical integrity testing. These more stringent requirements are necessary to ensure that USDWs are adequately protected from contamination by injected fluids.

The new regulations will require that all new injection wells be equipped with:

- tubing set on a packer;
- long string casing cemented to prevent fluid movement out of the injection zone; and
- surface casing run deep enough to cover all USDWs having total dissolved solids (TDS) concentrations ≤ 3000 mg/l and that the casing be cemented back to the ground level.

The only exceptions to the surface casing requirements are that:

(1) existing State requirements that are more stringent take precedence over these new EPA standards; or

(2) long string casing that has been cemented across a sufficient vertical interval t ensure that no fluid escapes from the injection zone; or

(3) where cementing surface casing to cover USDWs having 3000 mg/ TDS is impractical, the casing must extend below the base of those formations providing drinking water presently and for the foreseeable future; or

(4) the long string casing is cemented for a prescribed vertical interval across the base of the formation containing 3000 mg/l TDS water to isolate the upper USDWs fro possible fluid movement out of lower quality (i.e., higher TD levels) water.

EPA has sufficient evidence to support the requirement for redundant casing strings and/or mor frequent mechanical integrity testing of well components to ensur that USDWs are not endangered by failure of a single component withi the well. EPA considered proposing that all new wells have surface casing set to a depth sufficient to cover all USDWs having ≤ 10,000 mg/ TDS and that the casing be completely cemented back to the ground level. EPA also considered requiring that the long string casing be cemented back to the base of the surface casing.

These requirements would offer the greatest margin of protection to all USDWs; but, in the opinion of the Advisory Committee, would far exceed measures necessary to prevent fluid movement. In some instances, attempting to cement these long

intervals can actually create a significant hazard to a USDW by initiating vertical fractures within the confining formations or the aquifer during cementing operations. Furthermore, in some areas (e.g., California and Wyoming) the depths to the base of the lowermost USDWs (those formations having ≤ 10,000 mg/l TDS concentrations) are many thousands of feet. The mechanical requirements necessary to effectively cement these very long intervals are achievable, but technically impractical.

The UIC regulations require that all USDWs be protected down to a concentration level of ≤ 10,000 TDS. The UIC program has always followed that mandate. At least one string of casing must always be set through the base of the lowermost USDW (except in those wells where the well bore bottoms in formations having TDS concentrations ≤ 10,000 mg/l, as described above). Some Committee members initially felt that there should be redundant protection of USDWs to the 10,000 TDS level by requiring that two casing strings (surface and long string) be set through the base of the USDWs having ≤ 10,000 TDS. The Committee judged that running and setting a string of surface casing to cover all USDWs having concentrations of ≤ 10,000 TDS was unnecessary and technically impractical in many areas of the country. Formation water with TDS concentrations of 3000-10,000 mg/l would always be protected from contamination by injected fluids with a cemented long string casing. This requirement was determined to be fully protective of all USDWs.

Even if the extremely stringent construction standards are technologically achievable, the required additional capital investment costs would render many injection wells uneconomic and, ultimately, interfere with or impede the injection of brine and other fluids associated with oil & gas production. The collective cost to the domestic petroleum industry would be millions of dollars per year and would considerably reduce oil & gas production by making these wells uneconomic to drill and complete. The Committee agreed that construction standards required to guarantee 100% protection to any and all USDWs are impractical and unnecessary. Any such standards would violate the language and intent of Section 1425 of the SDWA.

Those existing injection wells that have fewer than the three prescribed construction elements (surface casing, long string casing and a tubing string set on a packer) will be required to undergo more frequent mechanical integrity testing. The current requirements are that all Class II wells must undergo a mechanical integrity test (MIT) at least once every 5 years. The new regulations will stipulate that:

- wells having two (2) of the prescribed construction elements be required to undergo an MIT every 3 years

- wells having only one element must submit to an annual mechanical integrity test.

For those new wells where running and cementing surface casing to 3000 mg/l TDS is technically infeasible, the long string casing should be perforated below currently-used water levels and intermediate cementing performed as necessary to protect 3000 mg/l TDS water from deeper, more saline water.

AREA OF REVIEW AND CORRECTIVE ACTION

The "area of review" (AOR) requirement was included as part of the UIC regulations to ensure that all improperly completed producing and injection wells and/or improperly plugged and abandoned wells are identified. All offset wells that might provide a vertical conduit by which injected fluids could migrate out of the injection zone and into a USDW must either be repaired or the operation of the permitted injection well modified (e.g., injection pressure and volumes reduced) to ensure that the USDWs remain undisturbed. In addition, current regulations exempt all injection wells "authorized by rule" (i.e., those injection wells existing prior to the implementation of the UIC program) from conducting area of reviews.

Abandoned and/or improperly plugged oil & gas wells usually penetrate a number of vertically stacked formations. If these wells are not properly sealed they can serve as vertical conduits by which injected fluids can migrate out of the injection zone, enter the old well bore and, if pressure and geological conditions are right, flow up and into a USDW. The current area of review (AOR) regulations were developed to identify all potential sources that would endanger USDWs and to assign responsibility for any associated corrective action that would be required to bring the well(s) into compliance with the regulations.

The regulatory language in 40 CFR 146.6 requires that all operators submitting a permit application for a new Class II injection well review all publicly available completion and plugging records for all wells that penetrate the injection zone and are located within a specified radius around each injection well. The radius of investigation for each AOR is defined by (1) calculating a "zone of endangering influence" based upon a standard mathematical equation (defined in 40 CFR 144.6) or (2) using a specified radial distance. Many States will not accept a radius of investigation based upon calculation of the zone of endangering influence because the necessary parametric data is either not readily available, of questionable accuracy, or subject to interpretation. The majority of the States require a radius of investigation for the AOR to be ¼ mile around the well. Oklahoma and New Mexico require that a ½ mile radius be used for the AOR.

Section 40 CFR 144.55 specifies that all operators applying for a Class II injection permit shall conduct an area of review. If the operator finds wells that are ".. improperly sealed, completed, or abandoned, the applicant shall also submit a plan consisting of steps or modifications as are necessary to prevent movement of fluid into underground sources of drinking water." The follow on activity to this plan is referred to as "corrective action." Any and all deficiencies that the UIC Director judges will put USDWs at risk from injected fluids must be corrected before injection is initiated. Criteria and standards to be applied in determining the adequacy of corrective action proposed by an operator are delineated in 40 CFR 146.7.

EPA originally believed that existing Class II wells should be exempt from area of review requirements "..because new injection wells are normally located

in existing oil fields [and] the review of abandoned and producing wells in the vicinity of new injection wells will, with time, result in the review of all other wells" (Federal Register, Vol. 44, pg. 23746, April 20, 1979). The rationale for granting an exemption for these wells authorized by rule lies in the hypothesis that as existing fields are further developed by additional, "in-fill" drilling the AOR coverage for the newly permitted injection wells would eventually encompass the AOR acreage around all existing wells. In most cases the prescribed radius of investigation is greater than the well spacing for the field. By constructing a circle of fixed radius around a new injection well a percentage of the circumscribed area would encompass the area around an existing well due to the overlap of the two circular areas. Because of this overlap, EPA believed that, over time, the AOR acreage around each existing well would be covered by the AORs conducted on the new wells. Eventually, all the productive area within a specific field would be subject to AOR procedures and appropriate corrective action would be taken as a result. The protection of USDWs would not be compromised.

EPA subsequently commissioned a study of injection well development history in Texas since primacy authority was granted in 1982 [7]. The study involved sampling a "universe" of 1455 fields that contained both existing (pre-1982) and new wells. The final sample consisted of 402 fields containing 9840 Class II wells. These wells represented approximately 18% of the total Class II inventory in Texas at the time of the study. The sample was stratified according to geographical area, size, and type of injection activity (e.g., brine disposal or enhanced recovery). The well distribution was then compared to the total sample to be sure that the percentages for the various well categories were representative of the entire well inventory. Results of the analysis showed that slightly less that 25% of the pre-1982 wells fell within the areal outline of the AORs conducted for post-1982 wells during the period from 1982 through 1990. Based upon this analysis, EPA now concludes that the assumption that all wells would eventually be covered by AOR is untenable and a change in regulatory policy is required.

PROPOSED CHANGES TO AOR AND CORRECTIVE ACTION REQUIREMENTS

The Committee recommended that EPA require that AORs be conducted for all wells authorized by rule that have not been included in previous AOR investigations. The Committee recommended that all AORs be completed within 5 years from the date that these new regulatory requirements are promulgated. This schedule was selected to coincide with the regulation (40 CFR 146.8) that all wells undergo a mechanical integrity test at least once every 5 years.

All owner/operators must conduct AORs and submit a corrective action plan. Wells located in known "high risk" areas where geological conditions are more likely to allow migration of fluids into a USDW would have to be reviewed and, if warranted, remediation work completed within 2 years after promulgation of the regulations. All other wells would have up to 5 years to be brought into compliance with the regulations.

The shorter time period was selected to coincide with the most stringent MIT requirements imposed upon operators under the current UIC program. The 2 year MIT requirement is imposed upon certain unconventional well completions in the Appalachian region where the construction standards and geology contribute to a greater potential for endangerment of local USDWs. The Committee encouraged EPA to provide appropriate guidelines to all States to enable them to identify and quantify the level of risk that various construction, geological and operating scenarios might impose upon local USDWs.

The Committee reached consensus that an exception to this AOR requirement would be allowed for those wells that have been granted a variance by the UIC Director based upon criteria presented in a detailed variance program plan that is submitted to, and approved by, the EPA.

State Directors considering the establishment of a variance program must notify EPA within 6 months after rule promulgation of their intent to issue variances. The Director would then have an additional 6 months (up to 1 year after the promulgation date of the regulations) to submit a variance plan. The variance plan shall consist of certain specified criteria, plans for public participation, and a schedule for identifying locales in which variances will be granted.

CONCLUSIONS

EPA proposes to amend the regulations governing construction standards and area of review requirements to afford greater protection of USDWs. As of the effective date of the final rule promulgation:

- All wells drilled or converted from a producing well, that was drilled after the effective date of the regulations, will be required to have (1) tubing set on a packer; (2) a long string casing, cemented partially or fully; and (3) cemented surface casing set through formations having ≤ 3000 mg/l TDS.

- All wells having only 2 construction elements will be required to undergo an MIT every 3 years.

- All wells having only 1 construction element will be required to undergo an MIT annually.

- An area of review must be performed on all Class II injection wells, including those previously exempt, unless (1) the well is overlapped by previous AOR studies of adjacent units; or (2) the well, project, field or basin is subject to a variance.

- Variances may be granted for areas where the risk of upward movement of injected fluids into USDWs is minimal based upon documented criteria such as (1) absence of USDWs; (2) pressure relationships between the injection zone and overlying USDWs; (3) the presence of local geologic conditions that preclude fluid movement; and (4) other compelling, scientific or engineering data supporting the issuance of a variance.

- EPA will issue appropriate guidance to the Directors specifying what criteria are required for an approved variance program.

ACKNOWLEDGEMENT

The authors wish to express their appreciation to all the members of the EPA Class II Advisory Committee whose insights and dedication laid the firm groundwork for these proposed regulations. Additional credit should be rendered to the technical staff of The Cadmus Group for much of the economic and statistical analysis supporting this effort.

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